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Integration of Unplugged Coding and Play-Based Learning in Daily Routine Activities to Develop Computational Thinking in Early Childhood

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Abstract

Developing computational thinking during early childhood requires learning experiences that are meaningful, engaging, and aligned with children's developmental characteristics. This study examines the use of unplugged coding integrated into play-based learning activities embedded within children's daily classroom routines at TK Piri Yogyakarta. A qualitative phenomenological design was adopted to capture the experiences of teachers and children during the implementation of this learning approach. The participants consisted of two early childhood teachers and eighteen children aged 5–6 years. Data were gathered through direct classroom observations, interviews with teachers, and analysis of supporting documents. The collected data were analyzed using Interpretative Phenomenological Analysis (IPA) to identify common patterns across participants' experiences. The findings indicate that incorporating unplugged coding into everyday play activities provides opportunities for children to develop essential components of computational thinking, including sequencing, pattern recognition through repeated actions, and simple decision-making based on cause-and-effect situations. The learning process also promoted active participation, collaborative interaction, and greater confidence among the children because the activities were closely connected to familiar daily experiences. These findings suggest that integrating unplugged coding into routine play activities offers a practical and child-centered approach for introducing computational thinking in early childhood education.

Keywords: *computational thinking; unplugged coding; play-based learning; early childhood education*

Abstrak

Pengembangan *computational thinking* pada anak usia dini memerlukan pengalaman belajar yang bermakna, menyenangkan, dan sesuai dengan karakteristik perkembangan anak. Penelitian ini bertujuan mengkaji penerapan *unplugged coding* yang diintegrasikan ke dalam pembelajaran berbasis bermain melalui aktivitas rutinitas harian di TK Piri Yogyakarta. Penelitian menggunakan pendekatan kualitatif dengan desain fenomenologis untuk memahami pengalaman guru dan anak selama pelaksanaan pembelajaran tersebut. Partisipan penelitian terdiri atas dua orang guru kelas dan delapan belas anak usia 5–6

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tahun. Data diperoleh melalui observasi langsung di kelas, wawancara dengan guru, serta analisis dokumen pendukung. Seluruh data dianalisis menggunakan **Interpretative Phenomenological Analysis (IPA)** untuk mengidentifikasi makna pengalaman yang dialami para partisipan. Hasil penelitian menunjukkan bahwa pengintegrasian *unplugged coding* dalam aktivitas bermain yang dikaitkan dengan rutinitas harian memberikan kesempatan kepada anak untuk mengembangkan kemampuan *computational thinking*, terutama dalam menyusun urutan kegiatan, mengenali pola melalui aktivitas yang berulang, serta mengambil keputusan sederhana berdasarkan hubungan sebab dan akibat. Selain memberikan manfaat pada aspek kognitif, pendekatan ini juga mendorong partisipasi aktif, kerja sama antarteman, dan kepercayaan diri anak selama proses pembelajaran. Temuan ini menunjukkan bahwa pemanfaatan *unplugged coding* dalam aktivitas bermain sehari-hari dapat menjadi alternatif pembelajaran yang efektif untuk memperkenalkan *computational thinking* pada pendidikan anak usia dini.

Kata Kunci: *computational thinking*, *unplugged coding*, pembelajaran berbasis bermain, pendidikan anak usia dini.

INTRODUCTION

Developing children's thinking abilities has become one of the primary priorities in contemporary education, particularly as schools prepare learners to meet the challenges of the twenty-first century (Fajri et al., 2026). Among the competencies receiving increasing scholarly and educational attention is computational thinking, which involves logical, systematic, and structured approaches to solving problems. Rather than being confined to computer science, computational thinking represents a broader cognitive process that enables children to recognize patterns, organize sequences, and generate solutions to simple problems encountered in everyday situations (Choiriyah et al., 2025). For young children, these abilities are especially important because learning at this developmental stage is most effective when supported by concrete experiences and active engagement with their surroundings.

As digital technologies become an inseparable part of children's everyday lives, educational practices are expected to cultivate not only technological familiarity but also essential thinking competencies (Ani Dwi Kumala & Andriani Purwastuti, 2026). Consequently, early childhood learning should emphasize the development of reasoning skills instead of merely introducing children to digital devices (Lee, 2026). Previous studies have demonstrated that computational thinking supports children's ability to approach problems logically, systematically, and efficiently (Akiba, 2022). Although the concept originated within computer science, it has gradually been adapted to early childhood education through contextual and meaningful learning experiences that reflect children's daily activities and developmental characteristics (Oktaviani et al., 2025).

Recent studies have increasingly highlighted that computational thinking can be nurtured through unplugged coding activities, logic-oriented games, and classroom experiences embedded within children's daily routines (Hardiyanti et al., 2025). These learning experiences enable children to develop sequencing abilities,

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recognize recurring patterns, and strengthen basic problem-solving skills (Utsman & Kusna, 2025). Children also tend to understand concepts more effectively when learning activities are connected with familiar experiences, as meaningful play naturally reflects their everyday lives (Kempirmase & Firman, 2025). Accordingly, play-based learning has become one of the dominant pedagogical approaches in early childhood education because it promotes exploration, social interaction, creativity, and meaningful hands-on learning within enjoyable classroom environments.

Despite the growing body of literature concerning computational thinking, unplugged coding, and routine-based learning, relatively few studies have specifically examined the integration of unplugged coding with play-based learning embedded in children's daily classroom routines (Nuarima et al., 2026). Existing research has predominantly emphasized structured instructional activities, while limited attention has been given to designing authentic play experiences that intentionally foster computational thinking skills (Rahmawati & Agustin, 2024). Furthermore, classroom play in many early childhood settings is still implemented primarily for enjoyment and socio-emotional development rather than being intentionally designed to cultivate higher-order cognitive skills, including computational thinking (Kurnia et al., 2026). This indicates a clear gap between the educational potential of play and its practical application in promoting children's cognitive development.

Addressing this gap requires a deeper understanding of how unplugged coding and play-based learning can be integrated into children's daily routines to meaningfully support computational thinking development among children aged 5–6 years. To address the identified gap, this research focuses on the application of unplugged coding within play-based learning activities that are incorporated into the daily routines of children at TK Piri Yogyakarta. In addition, the study seeks to identify forms of routine-based play that encourage children to follow sequential instructions, solve simple problems, generate creative ideas, and decompose complex tasks into smaller, manageable steps as fundamental components of computational thinking.

The present study is anticipated to enrich the existing literature on early childhood education by providing further evidence of the role of play-based learning in fostering computational thinking. In practice, the findings may serve as a reference for educators in designing learning experiences that are enjoyable, contextually meaningful, and developmentally appropriate while promoting children's higher-order cognitive skills.

METHODS

This study employed a qualitative research design using a phenomenological approach to explore how the integration of unplugged coding into play-based daily routine activities supports the development of computational thinking among young children. A phenomenological perspective was adopted because it allows

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researchers to examine and interpret participants' lived experiences within their natural learning environment. In this study, the focus was placed on understanding how teachers and children experienced routine classroom activities intentionally designed to incorporate unplugged coding through play-based learning. The research was conducted at TK Piri Yogyakarta and concentrated on children aged 5–6 years.

The participants consisted of two Group B classroom teachers and eighteen children aged between five and six years. Participants were selected through purposive sampling because they were directly involved in implementing routine-based learning activities that integrated unplugged coding with play-based pedagogy. Throughout the learning process, teachers acted as planners, facilitators, and classroom observers, while children actively engaged in various daily routines, including handwashing, mealtime, classroom transitions, organizing learning materials, and other routine classroom activities designed as playful learning experiences.

Data were collected using three complementary qualitative techniques: classroom observations, semi-structured interviews, and document analysis (Sugiyono, 2017). Classroom observations were conducted during twenty learning sessions to examine children's computational thinking behaviors within routine play activities. Particular attention was given to children's ability to follow sequential instructions, recognize patterns, solve simple problems, make decisions, and collaborate with peers during classroom routines. Semi-structured interviews were conducted with both classroom teachers to gain a deeper understanding of their experiences in planning, implementing, and evaluating unplugged coding activities integrated into everyday classroom routines. Documentary evidence, including Daily Lesson Plans (RPPH), children's developmental assessment records, field notes, and photographs of classroom activities, was analyzed to complement and verify the observational and interview findings.

The research instruments were developed based on computational thinking indicators considered appropriate for early childhood education. The observation instrument focused on four main dimensions: sequencing, problem solving, idea generation, and decomposition. These indicators were translated into observable behaviors and organized into an observation checklist to facilitate systematic documentation of children's responses during routine play activities. The interview guide was designed to explore teachers' perceptions regarding the implementation of unplugged coding, children's engagement, instructional challenges, and the educational value of integrating computational thinking into everyday classroom experiences.

The collected data were analyzed using Interpretative Phenomenological Analysis (IPA) following the framework proposed by (Smith et al., 2009). The analysis involved six iterative stages: (1) reading and re-reading the data to achieve familiarity with participants' experiences, (2) conducting initial noting, (3)

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developing emergent themes, (4) identifying relationships among themes, (5) repeating the analytical process for each subsequent case, and (6) identifying patterns across all participants. This analytical procedure enabled the researcher to interpret how teachers and children understood, experienced, and assigned meaning to routine-based play activities designed to foster computational thinking in early childhood education.

To enhance the trustworthiness of the findings, several strategies were implemented throughout the research process. Credibility was strengthened through prolonged engagement in the research setting, as classroom observations were carried out across twenty learning sessions, allowing the researcher to develop a comprehensive understanding of children's learning experiences and classroom interactions. Methodological triangulation was achieved by comparing evidence obtained from classroom observations, interviews, and documentary analysis to ensure consistency across different data sources. Member checking was conducted by sharing interview summaries and preliminary interpretations with the participating teachers to confirm the accuracy of the findings and provide opportunities for clarification. To improve dependability, an audit trail was maintained by documenting each stage of the research process, including observation records, interview transcripts, coding procedures, theme development, and analytical decisions. In addition, reflexivity was continuously practiced throughout the study. The researcher critically reflected on personal assumptions, professional background, and potential biases during data collection and interpretation to ensure that the findings faithfully represented participants' experiences rather than the researcher's expectations.

RESULTS

The findings indicate that integrating unplugged coding into play-based activities embedded within children's daily classroom routines created meaningful opportunities for the development of computational thinking among children aged 5–6 years at TK Piri Yogyakarta. Learning experiences that reflected familiar daily situations encouraged children to participate actively, interact confidently with peers, and construct new understanding through playful exploration. Across the classroom observations, computational thinking was consistently evident during routine-based play activities, suggesting that everyday classroom experiences provided an effective context for introducing computational thinking concepts.

Various classroom activities illustrated how unplugged coding was naturally incorporated into children's daily routines. These included sequencing picture cards representing everyday activities, role-playing familiar situations, movement-and-song games, and simple scenario-based activities. Rather than being presented as isolated learning tasks, computational thinking concepts emerged as an integral part of children's everyday play experiences. Children appeared to engage with these activities enthusiastically because they closely reflected situations encountered in their daily lives.

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Sequencing

The development of sequencing skills became apparent when children participated in activities requiring them to arrange picture cards illustrating familiar daily routines. They were able to organize activities such as waking up, taking a bath, eating breakfast, and going to school in a logical order. Similar abilities were observed during storytelling and role-play activities, where children successfully followed a series of teacher instructions while maintaining the intended sequence of actions. These experiences suggest that children's understanding of sequential processes was strengthened when learning tasks were closely connected to familiar routines.

Loops

Evidence of looping concepts emerged during movement-based games, songs, and repetitive classroom activities. Children repeatedly performed actions according to rhythms, classroom instructions, and established game rules while remaining actively engaged throughout the learning process. Repetition occurred naturally within playful interactions rather than through direct explanation, allowing children to recognize recurring patterns in an enjoyable manner. In several activities, children voluntarily repeated game sequences together with their peers, indicating that repetition had become part of their spontaneous play behaviour.

Conditional Thinking

Conditional reasoning was demonstrated through scenario-based play activities that encouraged children to make simple decisions according to changing situations. During weather-themed games, for example, children decided whether to play indoors or outdoors based on different weather conditions. Similar reasoning appeared during classroom activities involving simple reward systems, where children understood that completing assigned tasks resulted in receiving positive reinforcement. These experiences illustrate the emergence of basic if–then reasoning within meaningful situations that closely reflected children's everyday experiences.

The observational findings were further enriched by interviews with classroom teachers and the school principal. Both teachers explained that integrating routine classroom activities with play encouraged children to become more enthusiastic, engaged, and willing to participate throughout the learning process. According to one teacher:

"Children understand learning concepts more easily when the activities are presented as games. They feel that they are simply playing, yet at the same time they are following instructions, working together, and completing learning tasks."

The school principal similarly emphasized that meaningful learning occurs when educational activities are closely connected to children's daily experiences. According to the principal, routine-based play enables children to understand new concepts more naturally because the activities correspond to their developmental characteristics and everyday lives.

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Documentary evidence, including photographs of classroom activities, further supported these findings. The documentation illustrated children arranging daily routine sequences using picture cards, participating in role-play based on familiar home and school situations, constructing simple structures with blocks, and engaging in movement-and-song activities that emphasized repetitive action patterns.

Figure 1. Children arranging daily routine sequences (sequencing) using picture card games

Figure 2. Movement-and-song activities demonstrating repetition patterns (loops)

Figure 3. Scenario-based "if–then" games (conditional) in everyday contexts

Taken together, the observational records, interview data, and classroom documentation consistently indicate that children developed computational thinking through active participation in routine-based play experiences. Rather than learning computational concepts through explicit instruction, children constructed their understanding naturally while engaging in meaningful activities closely related to their everyday classroom experiences.

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Teachers also reflected on changes they observed in children's learning behaviors throughout the implementation of routine-based play activities. According to their experiences, children were initially more likely to require frequent guidance when following sequential instructions, maintaining attention during classroom activities, and completing tasks independently. As the learning activities became part of the children's daily routines, teachers perceived that the children participated more confidently, became increasingly engaged in classroom interactions, and collaborated more actively with their peers during play. These observations represent the teachers' interpretations of children's learning experiences rather than objective measures of behavioral change. Collectively, the interview findings suggest that embedding unplugged coding within routine play activities created a supportive learning environment in which opportunities to practice computational thinking emerged naturally through everyday classroom experiences.

DISCUSSION

The findings of this study indicate that computational thinking can be meaningfully introduced through routine play activities that are already embedded in children's everyday classroom experiences. Rather than treating unplugged coding as an isolated instructional activity, the present study demonstrates that computational thinking may emerge naturally when logical reasoning is integrated into familiar classroom routines. This extends previous studies, which have primarily examined unplugged coding through structured classroom tasks or teacher-directed activities. By embedding computational thinking into ordinary routines, such as daily transitions and role-play, children encountered computational concepts within authentic situations that required little separation from their normal learning experiences. This suggests that routine-based play may offer a more sustainable pedagogical approach because it minimizes additional instructional demands while maintaining children's engagement.

Classroom interactions also provided important insights into how computational thinking developed through collaborative learning. Consistent with Vygotsky's sociocultural perspective (Yuliantina, 2025), teacher guidance and peer interaction appeared to facilitate children's reasoning during sequencing games and scenario-based play. However, an interesting observation from the present study is that peer support gradually became more prominent as children became increasingly familiar with the activities. Unlike previous studies that primarily emphasize the teacher's scaffolding role, the findings suggest that collaborative interaction among peers may become equally important in sustaining children's engagement with computational thinking tasks during routine classroom activities.

Sequencing emerged as the computational thinking component most consistently demonstrated by the children. One possible explanation is that sequencing activities closely reflected routines that children repeatedly experience in their everyday lives, making the underlying logical structure easier to understand. Previous studies have similarly reported that algorithmic thinking develops more

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effectively when connected to familiar experiences (Salistina, 2026). Nevertheless, the present study extends this understanding by showing that sequencing does not need to be introduced through specially designed coding activities. Instead, ordinary classroom routines themselves can function as meaningful contexts in which children naturally organize events into logical sequences. This finding suggests that contextual familiarity may play a more influential role than instructional complexity during the early stages of computational thinking development.

The development of looping concepts appeared to occur through repeated physical movement and musical activities rather than through explicit explanations of repetition. This finding supports previous research highlighting the value of rhythmic and kinesthetic learning experiences (Ryscha Amelya et al., 2025). At the same time, the present study indicates that children's voluntary repetition of game patterns represented more than simple imitation. Their spontaneous decision to repeat activities with peers suggests that repetition became an intentional strategy for maintaining play and solving shared challenges. This interpretation broadens previous findings by emphasizing the importance of children's agency in constructing computational thinking concepts during play.

Conditional reasoning appeared to develop more gradually than sequencing because making decisions required children to interpret contextual information before selecting an appropriate response. Although previous studies have shown that young children can understand simple if–then logic through concrete situations (Sunimaryanti, 2026), the present findings suggest that meaningful contextual experiences are particularly important in supporting this process. Children demonstrated greater confidence when decision-making tasks reflected situations that they regularly encountered in school. This implies that contextual familiarity may reduce cognitive demands, enabling children to focus more effectively on logical reasoning.

Beyond computational thinking, the study revealed that routine-based play also promoted children's social participation. While earlier studies have consistently linked play-based learning with socio-emotional development (Afifah et al., 2025), the present findings suggest that the integration of unplugged coding may further strengthen collaborative interaction by encouraging children to negotiate ideas, explain reasoning, and solve problems collectively. These findings imply that computational thinking activities need not focus exclusively on cognitive outcomes but may simultaneously support broader developmental domains that are central to early childhood education.

One of the principal contributions of this study is the demonstration that computational thinking can be embedded within children's existing classroom routines without requiring dedicated coding lessons or digital technologies. Most previous studies have examined unplugged coding through structured interventions delivered during specific instructional sessions. In contrast, the present study illustrates how computational thinking can be integrated into naturally occurring

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classroom experiences, thereby reducing additional instructional demands while preserving the play-oriented philosophy of early childhood education. This perspective broadens the pedagogical application of unplugged coding and offers an alternative approach that may be more feasible for teachers working in resource-limited educational settings.

CONCLUSION

This study demonstrates that computational thinking can be meaningfully fostered by integrating unplugged coding into children's daily play routines at TK Piri Yogyakarta. Embedding computational thinking within familiar classroom activities enabled children to engage in learning through authentic experiences rather than formal coding instruction. The findings indicate that children demonstrated computational thinking across three key dimensions: sequencing, looping, and conditional reasoning. Sequencing skills were reflected in children's ability to organize actions logically, while looping concepts emerged through repeated play activities involving movement, music, and patterns. Conditional reasoning became evident as children made simple decisions based on cause-and-effect situations encountered during scenario-based play. Beyond these cognitive outcomes, the integration of unplugged coding also encouraged children's participation, communication, collaboration, and confidence during classroom activities.

These findings suggest that routine classroom activities can serve as meaningful contexts for introducing computational thinking in developmentally appropriate ways. Rather than requiring additional instructional time or digital technologies, teachers may incorporate unplugged coding concepts into everyday classroom routines such as transitions, storytelling, role-playing, and daily self-care activities. Curriculum developers and early childhood education practitioners may also consider embedding computational thinking into play-based learning as part of regular classroom practice to support children's cognitive and social development simultaneously.

This study was conducted in a single early childhood education setting using a qualitative phenomenological approach; therefore, the findings should be interpreted within this specific context. Future research is recommended to examine the implementation of routine-based unplugged coding across diverse educational settings and cultural contexts. Further studies employing mixed-methods or longitudinal designs may also provide broader evidence regarding the long-term development of computational thinking and contribute to the validation of assessment instruments for young children.

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